



## An Environmentally Safe Method for Knemidocoptosis Treatment of Peasant Farm Chickens in the Krasnodar City of Russia

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### Abstract

The article studies ectoparasitic contamination in three bird species (Kuropatchatayabrama, silver Orpington, and blue Orpington) of different ages from one to two years old and the effectiveness of the external application of birch tar 40°C with dimexide 20% for the treatment of knemidocoptosis of legs in chickens on peasant farms in Krasnodar city. Our research revealed the first time in Russian that all three species were contaminated by an association of ectoparasites (*Knemidocoptes mutans* + *Knemidocoptes gallinae*), localized in the chickens' legs. We publish the species composition of the mite association, infestation of the birds by *knemidocoptes*. Of 130 birds on the farm, 60 were contaminated. Clinical signs observed in the affected birds include hyperkeratosis with whitish film on the shank and hock region of their legs. Focal areas of sloughing of the skin with oozing of blood were also observed on the back and on the legs. After the first treatment course, the number of the infected birds diminished to 26, and the number of ectoparasites decreased significantly. After the second course, no infected birds were found. It was established that two applications of birch tar with dimexide cure an association of legs *knemidocoptes* mites in domestic chickens.

**Disciplinary:** Veterinary Medicine, Zoology, Biotechnology.

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# 1 Introduction

Knemidocoptosis is an infestation disease of birds caused by mites of the order acariformes belonging to the family Sarcoptidae, the genus Knemidocoptes, the species Knemidocoptesmutans (K.mutans)(legs), and Knemidocoptesgallinae(K.gallinae)(skin).

Knemidocoptesspp mites spend their entire three-week life cycle on their bird hosts. The females are viviparous, and the larvae have three pairs of legs. After two nymphal stages, the mites mature into adults that have four pairs of legs [1, 3, 8, 41].

Knemidocoptesspp is the most common burrowing mite that resides on the legs, feather follicles, and skin of domestic birds, spending most of their time under the skin, causing discomfort, and potentially life-threatening lesions. The spread of these mites occurs from prolonged close contact between birds, such as infestations of healthy birds, occurring through contact with adults, as well as through care items [10, 12, 15].

For the first time in literature, chicken scabies was described in India in 1778. Scabies in birds has been more fully described in Russia [5, 17, 27]. In Krasnodar Territory, knemidocoptosis is mainly found in small private farms or personal plots [1, 25, 34, 43]. The sick birds show the decline of productivity, and the roosters have more severe forms of the disease and they die more often. With time, the fingers fall off. When the body is involved, the birth feathers and fluff are lost. They eventually lose weight and die [23, 24, 39].

In urban and especially rural areas, there is a wide variety of breeds of domestic chickens in the peasant farms and private household plots (brama, cochinchin, silk Chinese, Orpington, maran), at present, a great interest in these farms is the species' composition of ectoparasites and the organization in them, therapeutic and prophylactic measures.

The purpose of this work is to establish the intensity and prevalence of infestation of ectoparasite contamination and study the effectiveness of the external application of birch tar and dimexide (1:1) for the treatment of knemidocoptosis of legs in chickens in peasant farms in the vicinity of the city of Krasnodar.

The novelty of the study is that for the first time in Russian Federation, the presence of an association of two types of mites on the legs of chickens and the possibilities of their treatment are studied. Such an association was not described in the available literature.

# 2 Literature Review

In industrial poultry farming, as well as in peasant farms, many environmental factors appear to inhibit their growth and development, reducing resistance and leading to the occurrence of parasitic diseases, and reduction of productivity. Therefore, in modern conditions of poultry farming, preventive monitoring of bird health is of particular importance [31, 33, 42].

Nowadays, knemidocoptosis is a serious disease for domestic chickens, which can spread to the entire population of birds in a short time resulting in their death without timely help [16, 29,30].

In industrial-type poultry farms, Chlorophos is used for the treatment of ectoparasites, as well as for the treatment of empty poultry houses inhabited by ticks. Currently, the veterinary service has a variety of drugs to combat ectoparasites of chickens [2,11, 21].

Some authors evaluated the effectiveness of treating birds with scaly leg affection with mites in India, Malaysia, Australia, and Belarus.

In India, the birds were treated topically with a 1:1 mixture of kerosene and neem oil, for 5 days continuously, and this mixture was found effective in the control of scaly leg infestation in a small population of backyard poultry [14]. In Malaysia in 2016, Siti et al. [40] used to treat birds with scaly leg mites Ivermectin at a dose rate of 0.2 mg/kg, given orally three times every fortnight over six weeks. According to a study conducted in Australia in 2012, the 0.1% ivermectin drop on liquid was effective for the removal of mites within two weeks [28, 36]. In 2019, in Tunisia, Kaboudi et al. [13] dissolved in slightly warm water a 0.6% solution of Dergall for the treatment of knemidosoptosis. Treatment was carried out three times with an interval of 5-7 days.

### 3 Method

This research work was carried out in 2017-2018 on the Krasnodar Territory. During this period knemidocoptosis was detected only in one peasant farm of "Yuzhnyi" village. Of the 130 birds of the breeds "Kuropatchatayabrama", silver Orpington, and blue Orpington, knemidocoptosis was found in 60 birds.

Clinical signs observed in the affected birds include lack of mobility, deformation of the fingers, hyperkeratosis with whitish film layer on the shank, and hock region of legs. Focal areas of sloughing of the skin with oozing of blood were also observed on the back and on the legs. The affected region was thickened. Some authors also note the same clinical signs [6, 9, 20, 26, 37, 38]. Of the 130 birds in the experiment, there were 50 roosters and 80 hens from 1 to 2 years.

Material for laboratory studies was scrapings of 2 scutes (one on each leg) of deep layers of the skin of the legs, taken from each of the sick chickens with a scalpel on the forge and in the fingers. The total number of scutes was 120 (taken from 60 diseased chickens). The size of the scutes was 6.48–18.20 mm in length, 3.61–10.8 mm in width, and 23.4–196.5 mm<sup>2</sup> of the surface. In the laboratory of the department of parasitology, veterinary expertise, and zoological hygiene of KubSAU, test objects were prepared, lactic acid was used to enlighten scutes, a scraping was taken with a needle and the mites were removed. The species belonging to the mites were established by measuring them with an eyepiece-micrometer scale (7x40).

To treat sick chickens with knemidocoptosis, dimexide 20% and a birch tar preparation in liquid form was used, one of the most effective, inexpensive preparations for owners of private plots [7, 18, 32]. The tar birch has acaricidal, disinfecting properties, It improves the blood supply of the tissues, moderately irritates sensitive nerve endings, stimulates the regeneration of the epidermis of damaged tissues, strengthens the keratinization process, dries up wounds, and accelerates their healing.

Dimexide (dimethyl sulfoxide) - concentrate for preparing a solution for external use. It is a colorless, transparent, odorless liquid or it has a slight specific odor. Dimexide has an anti-inflammatory effect, inactivates hydroxyl radicals, improves the course of metabolic processes in the inflammatory focus. It has a local anesthetic, analgesic, and antimicrobial action. It quickly and well penetrates the skin, mucous membranes, the membrane of microbial cells, and other biological membranes, increases their permeability to drugs.

During the treatment of sick chickens, the solution of dimexide (20%) and birch tar was prepared as follows: the legs of the chickens were dipped for 3 minutes into the bath with the mixture of dimexide and birch tar (40°C) in the ratio of 1:1. Such treatment was carried out twice with an interval of 10 days.

## 4 Result and Discussion

The mites were found in 3 breeds of chickens - the “Kuropatchatayabrama”, silver Orpington and blue Orpington. After the initial treatment, we noted that on the legs of the sick chicken, the flakes became dark gray, soft to the touch, and partially began to fall off. Under the microscope, the mites were found in the scrapings. A week after the second treatment, microscopic scrapings showed a complete absence of mites. Practically complete recovery of the birds occurred 2-3 months after the start of treatment.

The analysis of the farm chickens of the village "Yuzhnyi" revealed that three breeds of birds were infected with two species association of ectoparasites of the genus *Knemidocoptes*.

Table 1 shows the values of the prevalence of ectoparasites of each breed of birds before treatment. The least infected breed of birds turned out to be the silver Orpington – the prevalence 17(13.07%), the next was the blue Orpington with a prevalence of 20 (15.38%). The highest prevalence was in the “Kuropatchatayabrama” breed 23(17.69%). From a total of 130 birds at the beginning of the study, 60 birds were infected with a prevalence of 46.14% (an intensity of infestation of 65.8 birds).

**Table 1.** The results of the analysis of scutes of legs of 3 species of chicken, infected with a two-species association of mites genus *Knemidocoptes* in the farm D.V.Pashkovsky settlement "Yuzhnyi" (n = 130 birds).

Breed of birds	Before the treatment		
	Infected birds	Prevalence (%)	Intensity of infestation min, max, average
silverorpington	17	13.07	10-107 (64.1)
blueorpington	20	15.38	9-123 (68.2)
“Kuropatchatayabrama”	23	17.69	7-150 (65)
Total	60	46.14	7-150 (65.8)

The effectiveness of the mixture of the birch tar and dimexide for the association of *K.mutans* and *K.gallinae* is shown in Table 2. After the first course of treatment, the number of all ectoparasites was significantly diminished in all birds. The least infected breed was the Silver Orpington with the prevalence of 7(5.38%), and then the breed of Blue Orpington with the prevalence of 8(6.15%). The highest prevalence was at the breed “Kuropatchatayabrama” –

11(8,46%). In total, after the first course of treatment 26(19.99%) birds were still infected with the intensity of infestation of 13.4 birds.

**Table 2:** The effectiveness of the mixture of the birch tar and dimexide for the association of *K.mutans* and *K.gallinae* after the first course of treatment.

Breed of birds	After the first course of treatment		
	Infected birds	Prevalence (%)	Intensity of infestation min, max, average
silverorpington	7	5.38	10-23 (14.8)
blueorpington	8	6.15	6-25 (13.7)
“Kuropatchatayabrama”	11	8.46	1-36(11.6)
Total	26	19.99	1-36 (13.4)

After getting these results, the second course of treatment was done. After the treatment, the scutes were taken, and their analysis in the laboratory did not reveal any mites.

Microscopic identification of ectoparasites showed the presence of two species of the genus *Knemidocoptes*: *Knemidocoptesmutans* and *Knemidocoptesgallinae*. No mono infestation was detected. A study of the association of ectoparasites of each species of birds was conducted.

Table 3 shows the prevalence and intensity of infestation with ectoparasites of the Silver Orpington chicken. Of the 40 birds examined, 17 (42%) were contaminated with two types of ectoparasites before the first course of treatment, and 7 (17.5%) after. The average intensity of infestation of *K.mutans* was a little bit higher (66.5) than the one of *K.gallinae* (62). After the first course of the treatment of the average intensity of *K.mutans* was 15.4 and 14.1 for *K. gallinae*. After the second course of treatment, the mites were not detected.

**Table 3:** Species composition of the association of mites of the genus *Knemidocoptes* of the chicken’s silver Orpington, their prevalence and intensity of infestation before and after the treatment (n = 40 chickens)

Species of ectoparasites	infestation		Intensity of infestation min, max, average
	Infestedbirds	Prevalence (%)	
<b>Before the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	17	42.5	10-107 (66.5); 15-107 (62)
<b>After the 1<sup>st</sup> course of the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	7	17.5	10-19(15.4) ; 10-23 (14.1)
<b>After the 2<sup>nd</sup> course of the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	–	–	–

The species composition of the association of mites of the genus *Knemidocoptes* on the chickens' blue Orpington in Table 4 shows that of 40 birds 20 were infected before the first course of treatment with a prevalence of 50%, and 8 chickens after the treatment with a prevalence of 20%. The intensity of infestation of *K.mutans* was higher than the one of *K.gallinae*. The average intensity of infestation of *K.mutans* before the treatment was 73 and for *K.gallinae* it was 63.5. After our 1<sup>st</sup> course of treatment, the average intensity of infestation decreased from 16 for *K.mutans* and 11.5 for *K.gallinae*. After the second course of the treatment, the mites were not detected.

**Table 4:** Species composition of the association of mites of the genus *Knemidocoptes* of the chickens blue Orpington, their prevalence and intensity of infestation before and after the treatment (n = 40 chickens)

Species of ectoparasites	infestation		Intensity of infestation min, max, average
	Infestedbirds	Prevalence (%)	
<b>Before the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	20	50	11-123 (73); 9-119 (63.5)
<b>After the 1<sup>st</sup> course of the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	8	20	8-25 (16) ; 6-16 (11.5)
<b>After the 2<sup>nd</sup> course of the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	–	–	–

In the breed of chicken “Kuropatchatayabrama”, the association of ectoparasites in Table 5 was found in 23 out of 50 chickens before the first course of treatment with a prevalence of 46%. After the 1<sup>st</sup> course of treatment, 22% of the chickens remained with ectoparasites. The intensity of infestation of *K.mutans* was higher than the one of *K.gallinae*. The average intensity of infestation of *K.mutans* was 72.1 and for *K.gallinae* it was 58 before the treatment. After the 1<sup>st</sup> course of the treatment, the average intensity of infestation was 13.2 for *K.mutans* and 9.5 for *K.gallinae*. After the second course of the treatment, the mites were not detected.

**Table 5.** Species composition of the association of mites of the genus *Knemidocoptes* of the chickens “Kuropatchatayabrama”, their prevalence and intensity of infestation before and after the treatment (n = 50 chickens)

Species of ectoparasites	Infestation		Intensity of infestation (min, max, average)
	Infestedbirds	Prevalence (%)	
<b>Before the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	23	46	10-150 (72.1) ; 7-100 (58)
<b>After the 1<sup>st</sup> course of the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	11	22	1-36 (13.2) ; 7-25 (9.5)
<b>After the 2<sup>nd</sup> course of the treatment</b>			
<i>K.mutans</i> + <i>K.gallinae</i>	–	–	–

From the survey of 130 chickens (80 hens and 50 roosters) we obtained the following results presented in Table 6. Before the treatment of the legs of contaminated chickens with two types of ectoparasites, 31 of 80 hens and 29 of 50 roosters were contaminated with the following prevalence of 38.75% for hens and 58% for roosters. After the 1<sup>st</sup> course of the treatment, 10% of hens and 36% of roosters remained parasitized. Before and after the 1<sup>st</sup> course of the treatment, the intensity of infestation of ectoparasites in roosters was higher than in hens. After the first course of the treatment, the intensity of infestation highly decreased in both hens and roosters. After the second course of the treatment, the mites were not detected.

**Table 6:** Species composition of the association of mites of the genus *Knemidocoptes* in hens (n = 80 chickens) and roosters (n = 50 chickens), their prevalence and intensity of infestation before and after the treatment

Species of ectoparasites	Hens			Roosters		
	Infected birds	Prevalence (%)	Intensity of infestation (min, max, average)	Infected birds	Prevalence (%)	Intensity of infestation (min, max, average)
<b>Before the treatment</b>						
<i>K. mutans</i> + <i>K. gallinae</i>	31	38.75	10 – 107 (54); 7 – 98 (46)	29	58	27 – 150 (89); 18 – 119 (76)
<b>After the 1<sup>st</sup> course of the treatment</b>						
<i>K. mutans</i> + <i>K. gallinae</i>	8	10	8 – 25 (12); 9 – 23 (12)	18	36	1 – 36 (16.1); 1 – 25 (11.2)
<b>After the 2<sup>nd</sup> course of the treatment</b>						
<i>K. mutans</i> + <i>K. gallinae</i>	–	–	–	–	–	–

It should be noted that the most severe leg injury was observed in roosters. These results are in coherence [35]. According to Dubinin [3], this depends on the sensitivity to the effects of ectoparasites in roosters and hens. It should be noted that some authors also noted that roosters suffer from ticks much more than hens; the causes of death are more often recorded among roosters. Re-infestation of the hens is facilitated by the roosters, as they get sick more often and more intensively [22].

Our results regarding the sex of animals disagree with Lawal *et al.* [16] that the infestation was relatively higher in hens (46.25%) than in males (38.25%), with no statistically significant difference observed in the rate of infestation among the sexes.

After the measurements of ectoparasites, using the micrometer, we found that *K.gallinae* is larger than *K.mutans*, with body length 0.41-0.50 mm and width 0.34-0.50 mm. Bal *et al.* [4] during the research got the following results: the body length 0.31-0.58 mm, width 0.27-0.40 mm [3]. The mite *K.mutans* is more common in older birds. The mite has a spherical shape, the legs are short, the epidermis is sulcate, and the dorsal banding is not interrupted. In sick birds, partial or complete loss of phalanges of fingers is observed, as well as their death [42]. *K.mutans* mites have gray-yellow color and a more flattened ventral surface of the body. According to the data, obtained during our investigation, the body length is 0.30-0.38 mm and the width 0.26–0.31 mm.

From this study, 46.14% of chickens were infested with *Knemidocoptes mutans* and *Knemidocoptes gallinae*. The prevalence rate of *Knemidocoptes spp* was higher than that mentioned by Odenu *et al.* (7.26%) in Nigeria [23]. Rezaei *et al.* (7%) in Iran [30] and Bal *et al.* (7.26%) in India [3]. Other authors reported the prevalence of *Knemidocoptes gallinae* 11.45% and *Knemidocoptes mutans* 18.18% in Nigeria and southwestern Ethiopia [35,42]. The differences in the prevalence of *Knemidocoptes spp* are probably due to control measures against *Knemidocoptes spp* in these chickens [8].

According to [15], the high prevalence of ectoparasites may be associated with poor sanitation and hygienic practice which creates a favorable environment for the propagation and life cycle progression of the diverse parasitic species, inadequate housing facilities which can create

hiding places for the ectoparasite as well as the free-ranging management system of village chickens which may expose the chickens to arthropods of several genera.

Variations in the prevalence rates and diversity of species of ectoparasites from the reports of the various studies may be connected to several factors. The differences in geographical areas, host factors, husbandry, the sample size, period of study as well as different favorable climatic conditions such as temperature and humidity which may influence the population dynamics of the ectoparasites are the most included epidemiological factors [19].

## 5 Conclusion

This study showed that peasant farm chickens had external parasites of the genus *Knemidocoptes*. The species composition of the association of mites of the genus *Knemidocoptes* in chickens showed that birds were infected with two species of ectoparasites: *Knemidocoptes mutans* and *Knemidocoptes gallinae* which is known to adversely affect their health status and can even contribute to decreased productivity. The *knemidocoptes* mites spend their whole life on the birds, and because they are highly contagious, it's important to treat all the birds to bring out a solution to this problem. We have shown the effectiveness of using the mixture preparation of birch tar with dimexide for the treatment of *knemidosoptosis* of chickens. Disinfecting the birds' quarters is highly recommended as well. In this article, we described for the first time the association of two species of the mites *Knemidocoptes mutans* and *Knemidocoptes gallinae* in the disease of chicken legs in Russia.

## 6 Availability of Data And Material

Data can be made available by contacting the corresponding authors.

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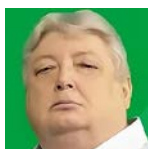
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